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A Low Cost Wireless Interfacing Device between PS/2 Keyboard and Display

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***Abstract*—A low cost interface using 8051 micro-controller is developed for data transition between IBM PS2 key board and a display device to flash the alphabets, numerals and special symbols directly to display by entering it from keyboard. Further additional electronic circuit developed for wireless data transmission between the two devices so that the displayed information can be changed using the keyboard from a distanced place. This helps to change the displayed information where display is situated at a place that is not easily accessible and facilitates the display operator.**

***Index Terms* - Embedded systems, 8051 based system, Keyboard and display interface.**

I. Introduction

IBM PS/2 key boards are widely used input device to give input in the form of numerals alphabets and special symbols. There is mean delay of 10 m-sec and a random error of +5 or -5 m-sec on PS/2 keyboard [1]. For a display device we need to give input to change the display in a real time situation. The PS/2 key board is use full in wide variety of application and its easy availability in the market is advantageous.Keyboards are nothing but a large matrix of keys, there is one on-board processor also called keyboard encoder that monitors all the keys. The processor may vary from one keyboard to another keyboard depending on brand but they do same basic process of monitoring the keys that which one is being pressed/released the appropriate data is send to the system for which key board is input device. Processor also takes care of the de-bouncing and buffers the required data in its 16-byte buffer [2].

The key board processor does the monitoring or "scanning" of key matrix. The process incorporates finding of key which is pressed, released, or held down and information in the form of data packet, "scan code" is send to your computer. The two types of "scan codes" are "make codes" and "break codes". A make code is information that is sent when a key is pressed. A break code is information that is sent when a key is released. A set of make and break code for every key comprises a "scan code set"[3].The micro-controller (8051), interfaced with PS/2 keyboard, tracks the "scan code" generated by the keyboard and interprets 'scan code' to corresponding alphabet, numeral or symbol. The ASCII code corresponding to the alphabet, numeral or symbol is transmitted wirelessly to the display using RF transmitter and receiver part with encoder and decoder (HT12E and the HT12D) [4]. Physics and media group at MIT media laboratory used HT12E & HT12D to develop a device for "Parasitic Power Harvesting in Shoes" [5]. An RF transmitter receiver pair (A434) is used for wireless communication to develop an Intelligent Combat Robot for war fields [6], Wireless Control of an Automated Guided Vehicle is developed using the RF transmitter and receiver pair [7].

II. About IBM PS/2 Keyboard

IBM introduced the keyboards we use today; IBM PS/2 Keyboard (1987) came with 84-101 keys and 6-pin mini-DIN connector. It has Bi-direction serial protocol that offers optional PS/2 scan code set 3 and 17 host-to-keyboard commands.

A. PS/2 Key Board Connector

To connect the keyboard with microcontroller the standard convention of the connector is followed. PS/2 key board connector is a 6 pin mini-DIN Figure1. The IBM keyboard uses the data to transfer the data and the clock pin is used for clock based synchronised data transfer. The Vcc (+5V) and ground pins are used to give power supply to the keyboard.

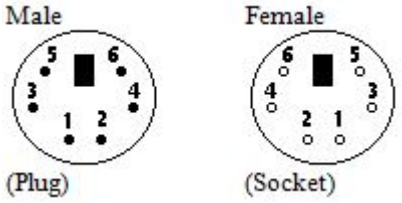

Fig. 1. PS/2 connector [2]

B. Electrical Specification

With a Vcc specification of +4.5V to +5.5V the max drawing current for key board is 275 mA. To connect the data and clock pins with microcontroller pull up resister should be connected, an external pull up registers is used in case there is no internal pull up resisters connected to microcontroller I/O pins.

C. 2.3 Data Communication

The bidirectional synchronous serial protocol is implemented in PS/2 keyboard. Data is send byte by byte, one byte of data is sent in a packet of 11 or 12 bit data packet. The transfer of one byte data from key board to microcontroller is sent is a packet of 11 bit TableI.

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TABLE I. DATA PACKET

Start bit (1-bit) always '0'	Data (8 bit) LSB first	Parity (1-bit) odd parity	Stop bit (1-bit) always'1'

The Data line changes state when Clock is high and that data is valid when Clock is low TableII. The clock frequency is 10-16.7 kHz and the maximum allowed is 30 KHz. The time from the rising edge of a clock pulse to a Data transition must be at least 5 microseconds. The time from a data transition to the falling edge of a clock pulse must be at least 5 microseconds and no greater than 25 microseconds figure2.

TABLE II. DATA, CLOCK, BUS STATE

Data	Clock	Bus State
High	High	*Idle*
High	Low	*Communication Inhibited*
Low	High	*Host Request-to-Send*

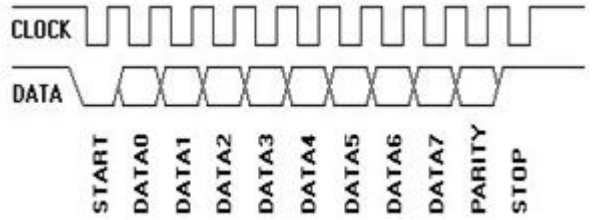

Fig. 2. Timing diagram [2]

D. Scan Codes

The keyboard sends the different scan codes for each different key pressed Table III. The scan code sent is independent of the condition that whether the caps are on or off, i.e. same scan code will be sent when the caps are on and when caps are off. For example the key 'A' sends the '1C' (Hex), key 'Q' sends the '15' (hex), F1 key sends the '05' (hex), etc. More characters or the longer scan codes are generated by some keys like PRT SCR, PAUSE, etc. The codes sent by the keyboard are HEX codes.

TABLE II. SCAN CODE

Key	Scan code (Hex)	Key	Scan code (Hex)
A	1C	N	31
B	32	O	44
C	21	P	4D
D	23	Q	15
E	24	R	2D
F	2B	S	1B
G	34	T	2C
H	33	U	3C
I	43	V	2A
J	3B	W	1D
K	42	X	22
L	4B	Y	35
M	3A	Z	1A

III. TRANSMITTER SECTION

The transmitting section is the PS2 keyboard side which includes the PS2 keyboard, microcontroller, HT12E and the RF transmitter module Figure3.

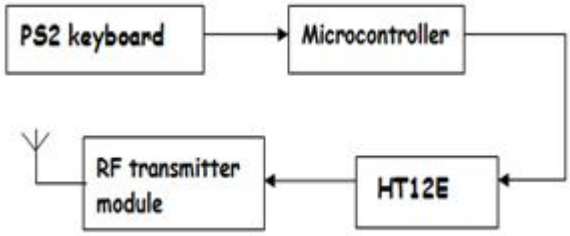

Fig. 3. Transmitter end

The PS2 keyboard sends the data serially to the microcontroller and the microcontroller interprets the hex code sent by the keyboard as discussed earlier.

A. HT12E

HT12E is an encoder IC which is capable of encoding information which consists of 8 address bits and 4 data bits. The operating voltage for HT12E is specified as 2.4V~12V and Low standby current is 0.1A at 5V. Address pins are specified as A0~A7, these pins can be externally set to +5V or left open according to the requirement of address that is allocated for secured transmission to the receiver. D8~D11 are the Input pins for data, D_{out} pin gives the data output serially Figure4. The input data to encoder is parallel and the output data is serial and the output is given to the RF module for the transmission.

The data input data to HT12E is in the form of nibbles (lower and upper nibble), that is transferred parallel. The address set on the pins of this HT12E should be same as of the address of decoder HT12D on receiver side, only then the data can be transferred can be decoded properly. A dynamic address allocation for transmitter and receiver can be done by connecting address pin to port pin of microcontroller and program it properly at both transmitter and receiver end. Address allocation gives advantage that the data can be sent only to the specified receiver by the transmitter. The serial data is sent to the RF module by connecting D_{out} pin of HT12E to the data pin 'D' of RF transmitter.

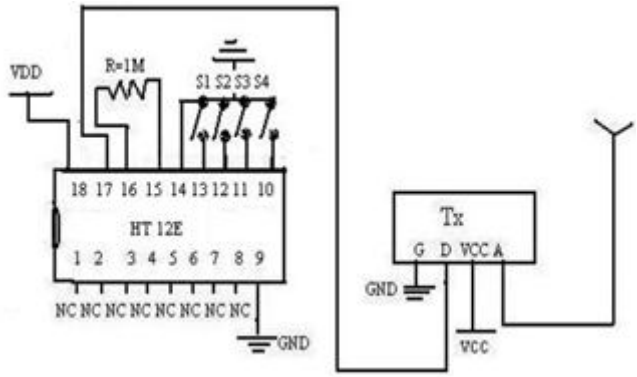

Fig. 4. HT12E and RF module interconnections [10]

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IV. Receiver Section

The receiving section is on display side which includes the RF receiver module, HT12D, microcontroller, and display Figure5.

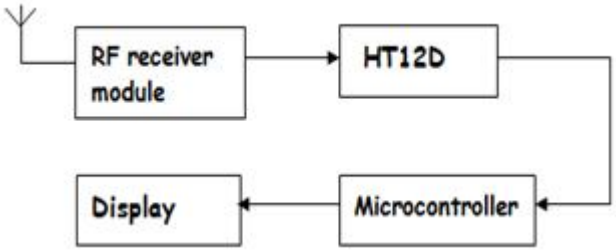

Fig. 5. Reciever end

The wireless data is received by the RF module serially and the HT12D receives the serial data and give the parallel data output to the controller after decoding it.

A. HT12D

HT12D is a decoder IC which is capable of decoding information which consists of 8 address bits and 4 data bits. HT12D has operates at voltage specified as 2.4V~12V, and provides low standby current. Address pin A0~A7 are the Input pins for address externally set to +5V or left open as per the address specified on transmitter side. D8~D11 are Output data pins, D_{in} is the Serial data input pin, VT is for the valid transmission, must be active high Figure6. The input data to decoder is serial and the output data is parallel. Data pin 'D' of RF receiver module is connected to D_{in} pin of HD12D.

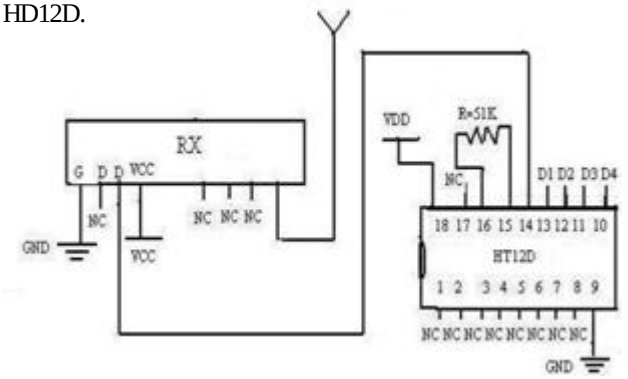

Fig. 6. RF and the HD12D interconnections [10]

V. Typing Speed And Display Response

A consideration of typing speed is important where it is a need to get the display content changed while typing in running hand. A theoretical model presents the upper and lower-bound text-entry rates on QWERTY keyboard [8]. The result is given in tabular form in Figure7.Considering 3475 peoples typing speed the statistics says that mean of speed of typing is 40 words per minute (WPM), median is 38 WPM and mode is 31 WPM with standard deviation of + 16.7 WPM from the median [9].

Upper-Bound and Lower-Bound Predictions

	Lower Bound		Upper Bound	
Bandwidth	Characters Per Second	Words Per Minute	Characters Per Second	Words Per Minute
4.9 bps	0.74	8.9	2.51	30.1
14 bps	0.92	10.98	7.05	84.56

Fig. 7. Theoretical typing speed [8]

Statistical Analysis Chart

Total Number =	3475
Mean =	40-WPM
Median =	38-WPM
Mode =	31-WPM
Standard Deviation =	+16.7-WPM from the Median.
Skew =	.52389
Error Variance=	.28705

Fig. 8. Typing speed (statistically)[8]

With time calculation the response of human to press key board key and delay in pressing keyboard key is in range of millisecond where the microprocessor response time is in the range of microseconds Figure8. With due consideration we can say that there will not be time issue in such case. However the display response time is one factor that depends on display type, colour and light condition and can be adjusted by changing microprocessor program using delays as per the practical situation.

VI. Simulation Result And Test Of Hardwired Model

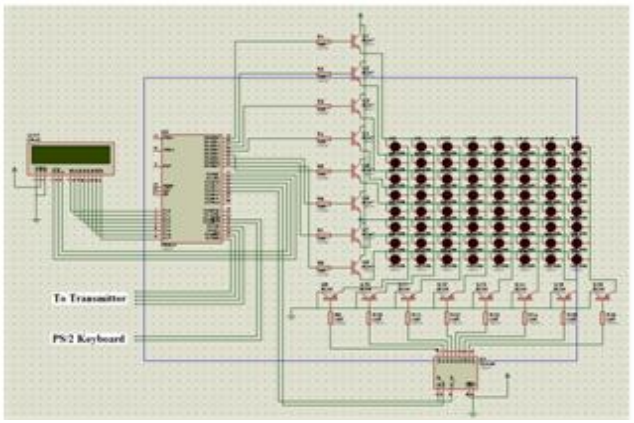

Fig. 9. Simulation result on Proteus

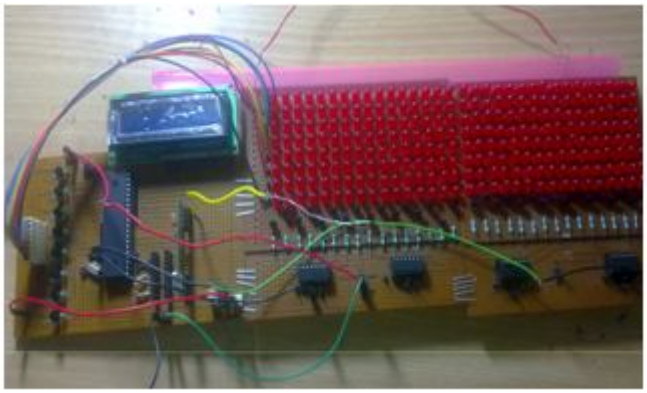

Fig. 10. Hardwired circuit

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Simulation of the circuit is performed on PROTEUS tool. The simulation result for display on LED was good. The hardwired circuit performance was as per the simulation result of PROTEUS Figure9. The program written for alphabets, numerals and special symbols were displayed on LED according to the key is pressed on keyboard. The range or transmitter and receiver are dependent on antenna quality with the antenna used transmitter and receiver communication was unaffected up to 90 meter range.

Conclusion

Both LCD and LED array are used as display to test the transmitter and receiver circuit working Figure10. It was found that working model was performing well within the practical distance range of 60-90 meter between transmitter and receiver, which depends on antenna attached with transmitter and receiver and the obstructions.

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